DOCUMENT RESUME

ED 062 001 PS 005 425

AUTHOR	Wilder, Larry; Harvey, Donald J.
TITLE	Overt and Covert Verbalization in Problem Solving.
INSTITUTION	Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
REPORT NO	WP-77
PUB DATE	Oct 71
CONTRACT	OEC-5-10-154
NOTE	18p.; Report from the Project on Variables and Processes in Cognitive Learning
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Analysis of Variance; *Articulation (Speech); *Cognitive Processes; Comparative Analysis; Early Childhood; Educational Psychology; *High School Students; Learning Processes; Nonverbal Communication; *Problem Solving; Research; Task Performance; *Verbal Communication
IDENTIFIERS	Covert Verbalization; Overt Verbalization

ABSTRACT

This study explored the effects of overt and covert verbalization instructions on problem solving in high school subjects. A series of three-circle problems were administered to groups instructed to either (1) say a reason for each move they made (overt verbalization), (2) think of a reason for each move as if they were going to say it (covert verbalization), or (3) work the problems silently (control). Consistent with previous findings, subjects instructed to overtly verbalize were superior to control subjects on a transfer task requiring no overt verbalization. No significant differences, however, were observed between overt and covert verbalizers. This finding was interpreted to indicate that, in adults, covert verbalization can be as effective in mediating problem solving behavior as talking aloud. It was suggested that this may not hold true for children, however. (For related document, see PS 005 424.) (Author)

ED 062001

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

Working Paper No. 77

Overt and Covert Verbalization in Problem Solving

By Larry Wilder and Donald J. Harvey

Report from the Project on Variables and
Processes in Cognitive Learning

Project Investigators: Herbert J. Klausmeier, Robert E. Davidson, Joel R. Levin, Thomas A. Romberg, B. Robert Tabachnick, Alan M. Voelker, Larry Wilder, Peter Wolff
Technical Development Section Director: Mary R. Quilling
Research Associate: Dorothy A. Frayer

Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
Madison, Wisconsin

October 1971

Published by the Wisconsin Research and Development Center for Cognitive Learning, supported in part as a research and development center by funds from the United States Office of Education, Department of Health, Education, and Welfare. The opinions expressed herein do not necessarily reflect the position or policy of the Office of Education and no official endorsement by the Office of Education should be inferred.

Center No. C-03 / Contract OE 5-10-154

PS 005425

NATIONAL EVALUATION COMMITTEE

Samuel Brownell
Professor of Urban Education
Graduate School
Yale University

Launor F. Carter
Senior Vice President on Technology and Development
System Development Corporation

Francis S. Chase
Professor
Department of Education
University of Chicago

Henry Chauncey
President
Educational Testing Service

Martin Deutsch
Director, Institute for Developmental Studies
New York Medical College

Jack Edling
Director, Teaching Research Division
Oregon State System of Higher Education

Elizabeth Koontz
Wage and Labor Standards Administration, U.S. Department of Labor, Washington

Roderick McPhee
President
Punahou School, Honolulu

G. Wesley Sowards
Director, Elementary Education
Florida State University

Patrick Suppes
Professor
Department of Mathematics
Stanford University

***Benton J. Underwood**
Professor
Department of Psychology
Northwestern University

RESEARCH AND DEVELOPMENT CENTER POLICY REVIEW BOARD

Leonard Berkowitz
Chairman
Department of Psychology

Archie A. Buchmiller
Deputy State Superintendent
Department of Public Instruction

Robert E. Grinder
Chairman
Department of Educational Psychology

Russell J. Hosler
Professor, Curriculum and Instruction

Clauston Jenkins
Assistant Director
Coordinating Committee for Higher Education

Herbert J. Klausmeier
Director, R & D Center
Professor of Educational Psychology

Stephen C. Kleene
Dean, College of Letters and Science

Donald J. McCarty
Dean
School of Education

Ira Sharkansky
Associate Professor of Political Science

B. Robert Tabachnick
Chairman, Department of Curriculum and Instruction

Henry C. Weinlick
Executive Secretary
Wisconsin Education Association

M. Crawford Young
Associate Dean
The Graduate School

EXECUTIVE COMMITTEE

Edgar F. Borgatta
Brittingham Professor of Sociology

Anne E. Buchanan
Project Specialist
R & D Center

Robin S. Chapman
Research Associate
R & D Center

Robert E. Davidson
Assistant Professor, Educational Psychology

Frank H. Farley
Associate Professor, Educational Psychology

Russell J. Hosler
Professor of Curriculum and Instruction and of Business

***Herbert J. Klausmeier**
Director, R & D Center
Professor of Educational Psychology

Wayne Otto
Professor of Curriculum and Instruction (Reading)

Robert G. Petzold
Associate Dean of the School of Education
Professor of Curriculum and Instruction and of Music

FACULTY OF PRINCIPAL INVESTIGATORS

Vernon L. Allen
Professor of Psychology

Ted Czajkowski
Assistant Professor of Curriculum and Instruction

Robert E. Davidson
Assistant Professor of Educational Psychology

Gary A. Davis
Associate Professor of Educational Psychology

M. Vere DeVault
Professor of Curriculum and Instruction (Mathematics)

Frank H. Farley
Associate Professor of Educational Psychology

Lester S. Golub
Lecturer in Curriculum and Instruction and in English

John G. Harvey
Associate Professor of Mathematics and of Curriculum and Instruction

Herbert J. Klausmeier
Director, R & D Center
Professor of Educational Psychology

Donald Lange
Assistant Professor of Curriculum and Instruction

James Moser
Assistant Professor of Mathematics Education; Visiting Scholar

Wayne Otto
Professor of Curriculum and Instruction (Reading)

Milton O. Pella
Professor of Curriculum and Instruction (Science)

Thomas A. Romberg
Associate Director, R & D Center
Professor of Mathematics and of Curriculum and Instruction

B. Robert Tabachnick
Chairman, Department of Curriculum and Instruction

Richard L. Venezky
Assistant Professor of English and of Computer Sciences

Alan Voelker
Assistant Professor of Curriculum and Instruction

Larry Wilder
Assistant Professor of Curriculum and Instruction

Peter Wolff
Assistant Professor of Educational Psychology

MANAGEMENT COUNCIL

Herbert J. Klausmeier
Director, R & D Center
V.A.C. Henmon Professor of Educational Psychology

Mary R. Quilling
Director
Technical Development Program

Thomas A. Romberg
Associate Director

James Walter
Director
Dissemination Program

Dan G. Woolpert
Director
Operations and Business

* COMMITTEE CHAIRMAN

STATEMENT OF FOCUS

The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement fo related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This Working Paper is from the Project on Variables and Processes in Cognitive Learning in Program 1, Conditions and Processes of Learning. General objectives of the Program are to generate knowledge ond develop general taxonomies, models, or the development of curriculum materials and procedures. Contributing to these Program objectives, this project has these objectives: to ascertain the important variables in cognitive learning and to apply relevant knowledge to the development of instructional materials and to the programming of instruction for individual students; to clarify the basic processes and abilities involved in concept learning; and to develop a system of individually guided motivation for use in the elementary school.

CONTENTS

		Page
	Abstract	vii
I	Introduction	1
II	Method	4
	Subjects	4
	Materials	4
	Procedure	4
III	Results	7
IV	Discussion	10
	References	13

FIGURE LIST

Figure		
1	Mean moves in excess of minimum for overt, covert, and control verbalization groups on the training and transfer problems.	8

ABSTRACT

This study explored the effects of overt and covert verbalization instructions on problem solving in high school subjects. A series of three-circle problems were administered to groups instructed to either (1) say a reason for each move they made (overt verbalization), (2) think of a reason for each move as if they were going to say it (covert verbalization), or (3) work the problems silently (control).

Consistent with previous findings, subjects instructed to overtly verbalize were superior to control subjects on a transfer task requiring no overt verbalization. No significant differences, however, were observed between overt and covert verbalizers. This finding was interpreted to indicate that, in adults, covert verbalization can be as effective in mediating problem solving behavior as talking aloud. It was suggested that this may not hold true for children, however.

I

INTRODUCTION

The relationship between thinking and verbal processes is a compelling issue confronting many behavioral scientists. Problem-solving paradigms, which seemingly require higher-order learning, have occasionally been used to examine this relationship. For example, Gagné and Smith (1962) studied the effects on learning and transfer of having subjects verbalize while solving problems. They also examined the effect of instructions to search for a general principle to be stated verbally upon completion of the problems.

The Gagné and Smith experiment was based on a series of three circle tasks which required that the subject transfer a number of discs of graduated diameter from one of the circles to another, moving only one disc at a time. While the principle of solution remained the same, the problems increased in complexity from a two- through a five-disc task. One of the groups in this study was instructed to state aloud a reason for each move as it was made, a second group was instructed to search for a general principle, a third received both instructions, and a fourth, the control group, was simply informed of the rules and worked silently. On the transfer task (a six-disc problem performed silently by all groups),

verbalizers were highly superior to both the group instructed to search for a general principle and the control group, as indexed by total time to solution and moves taken in excess of the minimum required to solve the problem. In interpreting their findings, Gagné and Smith noted the lack of theory relevant to their findings, but suggested that requiring subjects to verbalize "somehow forced them to think" during the practice trials.

Another line of research related to verbalization has developed quite independently of the problem-solving literature. This latter group of studies, for the most part utilizing verbal learning paradigms, has emphasized the role of overt verbalization in learning (Carmean & Wier, 1967; Mechanic, 1964; Murray, 1965, 1966, 1967; Wilder, in preparation). Carmean and Wier, for example, found that pronouncing the correct response in a discrimination task is superior to rehearsing the correct response silently. The authors concluded that "overt verbalization has a memorial effect which influences both learning and recall" (p. 549). Four possibilities as to why overt verbalization has a facilitative effect were offered, but the "scanty evidence available" for explaining this effect was noted.

While Gagné and Smith (1962) operationally defined "verbalization" as talking aloud during task performance, the perspective mentioned above emphasizes the vocal component in verbal behavior. Thus, while a subject's speech is a convenient index of his covert verbal behavior, studies examining spoken versus silent learning suggest that speech may have a function quite apart from communicating with

experimenters while solving problems.

It seems presumptious to assert that the subjects (Ss) in the Gagné and Smith control group were verbalizing silently while performing the three-circle problem, and that this covert verbalization was not as efficient as overt verbalization. Therefore, the present study attempted to elicit covert verbalization with a bit more assurance, and to compare the effects of instructions to covertly verbalize with instructions to talk out loud while solving the three-circle problem. If there are unique facilitative effects associated with instructions to overtly verbalize, then overt verbalization subjects should be superior to subjects instructed to covertly verbalize, or to subjects given no verbalization instructions.

Using the same three-circle problem and procedures reported by Gagné and Smith, this study examined training (two- through five-disc problems) and transfer (six-disc problem) effects of overt and covert verbalization instructions, in addition to instructions containing no verbalization requirement. One limitation of the Gagné and Smith study was that while they counted the number of moves during the training problems, they did not record the time to solution for these problems. Nevertheless, they reported that, during the two- through five-disc problems, "the making of moves was slower for those Ss who were required to verbalize" (p. 14). Consequently, it could be argued that the superior performance of verbalizers was due to the greater amount of time spent on the training tasks. To clarify this issue, time to solution for each training task was recorded in the present study.

II

METHOD

Subjects

Gangé and Smith (1962) used 14- and 15-year-old male volunteers. In the present study, the 30 subjects were 17- and 18-year-old male volunteers who were attending summer clinics in Speech and Journalism at the University of Wisconsin. The only requirement for participation was that the subject had no previous knowledge of the three-circle problem.

Materials

The three-circle problem cited by Gagné and Smith was constructed according to similar specifications. The discs were cut from 3/32-inch aluminum and graduated in diameter from 3/4 inch to 2 inches. The discs were numbered one through six in order, from the smallest to the largest. Three circles of 4 inches in diameter were drawn on a piece of light grey construction paper with their centers at the apexes of an equilateral triangle having 6-inch sides. The circles were lettered A, B, and C.

Procedure

The procedures were similar to those described by Gagné and Smith. Each subject was shown the materials and informed of the rules of the game. The three- and four-disc tasks were then administered

until each was carried to final solution. During these warm-up trials, subjects were encouraged to ask any questions pertaining to the instructions and were permitted to retrace a wrong move as far back as the beginning. The purpose of this exercise was to fully acquaint the subjects with the problem, as well as to establish a relaxed experimental atmosphere.

Each subject was then randomly assigned to one of three experimental conditions, each containing ten subjects. The control group received the following instructions:

> You will see on the table three circles, A, B, and C. A number of discs will be placed on Circle A. The largest disc is on the bottom, the next largest is next to the bottom, etc., so that the smallest is on top. Your task is to transfer these discs to Circle B in the least number of moves possible so that they will be in the same order. You may move only one disc at a time. You may move only discs that are on top of a pile or that are alone. You must not place a larger disc on a smaller. A disc moved from one circle must be placed in one of the other circles. The number of moves it takes you to complete the problem and the time will be recorded. There is no time limit, however, so do not hurry your moves. You may back up at any point and retrace your moves.

Overt verbalization subjects received the same instructions as the Control group plus the following:

> State out loud a full reason for each move as completely as you can. If you are not certain of the reason for a specific move do not hesitate to say so. If you choose to back up at any point be sure to verbalize a reason for each move as you retrace your steps.

Covert verbalization subjects received the same instructions as the Control group plus the following:

> Carefully consider each individual move. Think of a full reason for each move as if you were being asked to report

your reason out loud. Do not move until you feel confident there is a good reason for the move you are about to make. Remember to approach each move as if you were being required to state your reason out loud.

The subjects were then presented with the two-, three-, four-, and five-disc tasks in succession which they worked through to completion. A 1-minute interval followed each task through the five-disc trial. These short rest periods were filled with casual conversation generally unrelated to the problem situation.

Immediately preceding each task, overt verbalization subjects were reminded to approach each consecutive move as if they were being required to verbalize a complete reason. Control subjects were simply reminded not to place a larger disc atop a smaller or to move only one disc at a time. All subjects were informed of the minimum number of moves possible for solution of each task ($2^n - 1$). A 3-minute interval preceded the final six-disc transfer task. All subjects were told to work silently on the final task and to approach the problem in whatever manner they chose.

III

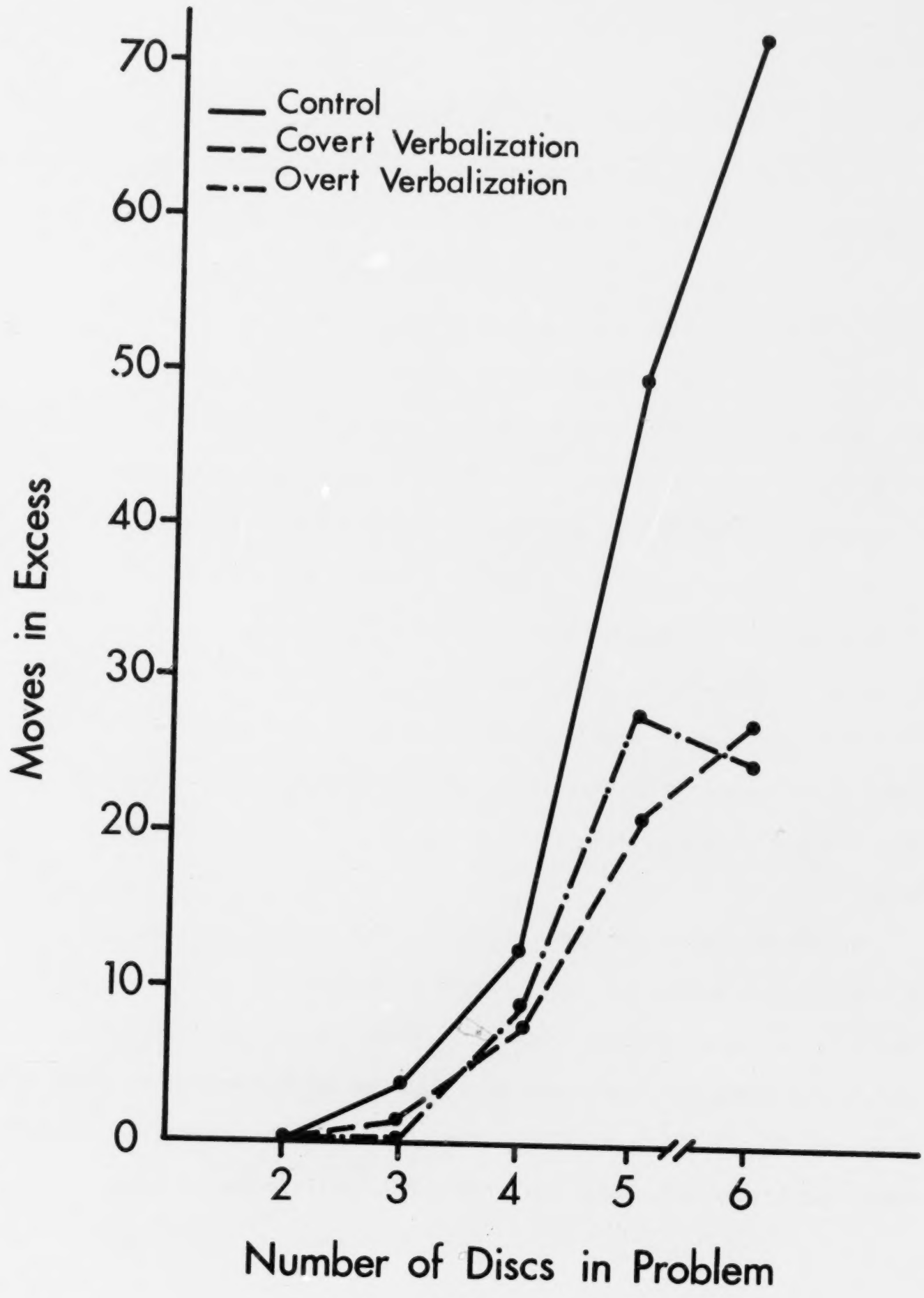
RESULTS

Total time to solution and total moves were analyzed in a 3 by 5 analysis of variance, with three levels of Verbalization (overt, covert, control) and five Tasks (two, three, four, five, and six discs). The Task factor was a within subjects variable.

The control group averaged 27.32 excess moves over all tasks, while mean excess moves for overt verbalization and covert verbalization groups were 12.88 and 12.30, respectively. This main effect of verbalization conditions was significant ($F = 18.63$; $df = 27$; $p < .001$). Scheffé pair-wise comparisons revealed significant differences between the control group and each of the two verbalization groups ($p < .01$). This finding indicates that verbalization subjects, overt and covert, made significantly fewer excess moves on the training and transfer disc problems than the control group. The contrast between the overt and covert groups did not approach significance.

The Verbalization by Task interaction was also significant ($F = 7.25$; $df = 8,108$; $p < .001$). This interaction is shown in Figure 1. A trend analysis revealed a strong linear component to the differences among the conditions as a function of the number of discs ($F = 5.99$; $df = 8,108$; $p < .001$). The differences in quadratic, cubic, and higher components were not sufficiently great to have

Figure 1. Mean Moves in Excess of Minimum for Overt, Covert, and Control Verbalization Groups on the Training and Transfer Problems



produced the significant interaction. Further, Scheffé pair-wise comparisons indicated that the differences among conditions as a function of the number of discs resulted from the difference between the control group and each of the verbalization groups ($p < .01$). There was no significant difference between the overt and covert verbalization groups.

The time to solution measure yeilded no significant differences among the verbalization and control groups ($F < 1$), and Verbalization did not interact with Task ($F < 1$).

IV

DISCUSSION

These results were remarkably similar to those reported by Gagné and Smith (1962). Overt verbalization subjects were superior to control subjects as early as the three-disc problem (see Figure 1), and this difference in performance increased as more discs were added. However, the time-to-solution measure yielded no significant differences among the two verbalization groups and the control group. This finding suggests that, while verbalization subjects made fewer moves in excess of minimum over tasks than the control group, all three groups took approximately the same amount of time in solving each successive problem.

While Gagné and Smith did not measure time-to-solution on the training tasks, they found overt verbalization subjects faster than control subjects on six-disc performance. Perhaps the present results differ with the previous study because of instructions. While Gagné and Smith reported that their subjects were informed of the time-to-solution and the number-of-moves measures, subjects in the present study were further told "there is no time limit, however, so do not hurry your moves." Thus while the act of verbalization could be expected to slow down overt verbalization subjects, the instructions not to hurry could have had similar effects on control and covert verbalization subjects. Assuming this were the case, the pre-

sent study provides even stronger support for the facilitative effects of verbalization, since it cannot be argued, as was the case in the Gagné and Smith study, that overt verbalization subjects spent more time on the training problems.

There was no significant difference between the performance of overt and covert verbalization subjects as indexed by the excess-moves and time-to-solution measures. These results imply that if covert verbalization instructions were employed in the studies previously cited (which they were not), covert as well as overt verbalization could be demonstrated to be superior to silent performance.

Thus, while Carmean and Wier (1967) stressed tentative hypotheses concerning the unique effects associated with saying items out loud during learning, the present study (using a different task) suggests that covert verbalization may be the actual mechanism facilitating learning, and having subjects talk out loud during experiments may simply insure activation of this mechanism. This explanation is consistent with Vygotsky's (1962) theoretical account of the internalization of speech during the course of human development (See also Flavell, Beach & Chinsky, 1966; Kingsley & Hagen, 1970; and Kohlberg, Yaeger, & Hjertholm, 1968). According to Vygotsky, young children need to talk to themselves during problem solving. This overt dialogue-with-self reflects the child's not yet fully developed internal verbal connections which mediate problem-solving behavior at a later stage of development.

The results of the present study can be interpreted within this theoretical perspective. Verbal mediation (i.e., hypothesis testing, strategy, or whatever) aids performance on the three-circle problem. In high school students, this verbal mediation can be elicited by requesting the subject to talk while solving each successive problem, or by asking him to silently mediate. However, this may not be the case with young children, and perhaps speech as an overt verbal process is an important stage in the development of verbal behavior.

The three-circle problem might yield useful data relevant to the role of speech in the development of verbal behavior. For example, from the above theoretical consideration, one might hypothesize that if no instructions about verbalization were given, younger children would spontaneously talk more during problem-solving than older children. Further, inhibition of this spontaneous verbalization in younger children should lead to decreased efficiency in task performance. Finally, instructions to verbalize covertly should not be facilitative in younger children.

CPO 825-007-3

REFERENCES

Carmean, S. L., & Wier, M. W. Effects of verbalization on discrimination learning and retention. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 545-550.

Flavell, J. H., Beach, D. R., & Chinsky, J. M. Spontaneous verbal rehearsal in a memory task as a function of age. Child Development, 1966, 37, 283-299.

Gagné, R. M., & Smith, E. C., Jr. A study of effects of verbalization on problem solving. Journal of Experimental Psychology, 1962, 63, 12-18.

Kingsley, P. R., & Hagen, J. W. Induced versus spontaneous rehearsal in short-term memory in nursery school children. Developmental Psychology, 1970, 1, 47-58.

Kohlberg, L., Yaeger, J., & Hjertholm, E. Private speech: Four studies and a review of theories. Child Development, 1968, 39, 691-736.

Mechanic, A. The responses involved in the rate of learning of verbal materials. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 30-36.

Murray, D. J. Vocalization-at-presentation and immediate recall, with varying presentation rates. Quarterly Journal of Experimental Psychology, 1965, 17, 47-56.

Murray, D. J. Vocalization-at-presentation and immediate recall, with varying recall methods. Quarterly Journal of Experimental Psychology, 1966, 18, 9-18.

Murray, D. J. Overt versus covert rehearsal in short-term memory. Psychonomic Science, 1967, 7, 363-364.

Wilder, L. Spoken rehearsal and verbal discrimination learning. University of Wisconsin Research and Development Center for Cognitive Learning, Working Paper No. 76, in preparation.

Vygotsky, L. S. Thought and language. Cambridge, Mass.: MIT Press, 1962.

GPO 825-007-2